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BIOLOGICAL EVALUATION OF PEST CONDITIONS AND POTENTIAL HAZARD TREES IN SELECTED CAMPGROUNDS ON THE COCONINO NATIONAL FOREST, ARIZONA

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BIOLOGICAL EVALUATION OF PEST CONDITIONS AND POTENTIAL HAZARD TREES IN SELECTED CAMPGROUNDS ON THE COCONINO NATIONAL FOREST, ARIZONA

MARCH 1990

By

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ACKNOWLEDGEMENTS

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INTRODUCTION

In 1989, Forest Pest Management in Region 3 initiated an insect and disease incidence survey of recreation sites. These surveys were conducted to evaluate the overall "health" of proposed and existing campground (CG) areas on the National Forests. Loyd Barnett, Land Management Planning Officer and Jim Beard, Landscape Architect, supplied a list of campgrounds to evaluate on the Coconino National Forest. The information supplied in this report offers pest management considerations for vegetation management plans. The areas surveyed include:

Ranger District (RD)	Campground (CG)	Status
Sedona RD	Pine Flat CG	Existing
	Cave Springs CG	Existing
	Redrock Crossing CG	Existing
Blue Ridge RD	Moqui Use CG	New
	Rock Crossing CG	Existing
Mormon Lake RD	Pine Grove CG	Reconstruction

OBJECTIVES

The objectives of this survey were to: (1) Evaluate and document the incidence of insect and disease activity and damages in proposed and existing recreation sites, and (2) detect and document hazardous trees in developed sites.

METHODS

The procedures followed are described in the "Inventory of Insects, Diseases, and Hazard Tree Incidence Work Plan for Developed and Proposed Recreation Sites of National Forest System Lands, Southwest Region" (Rogers, 1989). The study within each recreation area was two part; a hazard tree analysis and an insect and disease survey. The hazard tree analysis was patterned on procedures described by Johnson (1981). A hazard tree is defined as any tree with both a mechanical defect that could cause the tree to fail and a potential target. Only trees showing structural defects and located in areas of intensive public use, e.g. within and adjacent to camping sites, toilets, and parking pads, were evaluated. The individual tree data included: Species, diameter inside bark (DIB), location, defect, and hazard rating, which was recorded on a Tree Hazard Evaluation Form (see Appendix).

The hazard rating system used is a two-part failure/risk rating system, each part using a descriptive rating scale of High (H), Medium (M), and Low (L) to estimate probability. The first part of the rating system is an estimate of the probability of mechanical failure of the tree, or major portions of the tree, within the next five years. This estimate is based on a number of factors including: Presence of decay, condition and location of roots and

crowns, and amount of lean. The second part of the rating is an estimate of the probability of injury to people or damage to property if the tree does fail. Only trees located in areas more likely to be occupied by people or property (risk rating = high or medium) were recorded on the evaluation forms.

The insect and disease survey was performed as a Region 3 Stage II Stand Exam Survey described in the Region 3 Silvicultural Examination and Prescription Handbook, FSH 2409.26d. The following data were collected for each tree recorded on the plot: Species, diameter at breast height (DBH), height, tree history, a damage code, and a code for dwarf mistletoe rating (DMR) (Hawksworth, 1977). The data was recorded on the Region's Forest/Stand Tree Record Sheet and run through the Region 2/3 Stage II Data Entry/Runstream Generation Program. The runstreams were submitted to Fort Collins Computer Center for processing.

RESULTS AND DISCUSSION

Most sites surveyed are of the ponderosa pine vegetation type with a mixture of Gambel oak and juniper. Pine Flat CG has an additional mixture of riparian species bordering Oak Creek. Red Rock PA is strictly in a riparian habitat, consisting of Arizona sycamore, cottonwood, and Arizona cypress. A total of 39 hazard trees were recorded in the six recreation sites surveyed. The number of trees per site in each rating class or category are listed in Table I. The majority of hazard trees found were dead or had dead tops or limbs and were rated in the high failure/high risk category. Both hardwoods and conifers were defective. Red Rock PA had the greatest number of hazard trees (24), due to its strong hardwood component. The heavy branches and wide spreading nature of sycamore and cottonwood crowns makes dead tops or branches potentially more hazardous than in pines. Detailed information on defective trees and their location are on Tree Hazard Evaluation Forms for each site in the Appendix.

The hazard ratings provided are not recommendations for action. They are a professional estimate of the probability of tree failure and should be used by the land manager during the decision-making process for management plans in recreation areas.

Table II. Information from Stage II stand examinations of some recreation sites on the Tonto National Forest.

Campground		Understory	Overstory	Total
Zane Grey	QSD[a]	4.6	13.8	5.5
	BA[b]	19	9	29
	#stem[c]	166	9	175
Upper Canyon	QSD	13.0	26.2	15.3
	BA	57	34	91
	#stems	63	9	71
Airplane Flat	QSD	14.0	24.0	15.9
	BA	86	42	128
	#stems	80	13	94
Colcord Ridge	QSD	7.2	20.8	8.8
	BA	58	35	94
	#stems	206	15	221
Valentine Ridge	QSD	5.0	18.7	6.3
	BA	59	42	101
	#stems	438	22	460

[a]QSD=quadratic stand diameter

[b]BA=basal area/acre

[c]#stems=#stems/acre

Table III. Dwarf mistletoe ratings (DMR) of some recreation sites on the Tonto National Forest.

	DMR[a]			DMC[b]
Campground	understory	overstory	total	
Zane Grey	.9	1.9	.9	7
Upper Canyon	0	0	0	0
Airplane Flat	.3	.5	.3	2
Colcord Ridge	1.3	1.9	1.4	9
Valentine Ridge	.5	2.5	.6	9

[a]DMR = Hawksworth's (1977) dwarf mistletoe rating

[b]DMC = Dwarf mistletoe class system (see text)

Tables II and III summarize information from the stand examinations. Site densities are similar with the exception of the proposed Zane Grey CG which shows a very low BA (29) due to the high rate of manzanita and other nontimber species. Southwestern dwarf mistletoe (DM) (see Biology of Pests) was the only pest observed causing significant damage.

Zane Grey - The high DMR (Table III) in Zane Grey represents severe DM

Table III. Dwarf mistletoe ratings (DMR) of some recreation sites on the Coconino National Forest.

	DMR[a]			DMC[b]
Campground	understory	overstory	total	
Pine Flat	.2	.5	.2	2
Cave Springs	0	0	0	0
Moqui Use	0	0	0	0
Rock Crossing	0	2.0	0	5
Pine Grove	0	0	0	0

[a]DMR=Hawksworth's (1977) dwarf mistletoe rating.

[b]DMC=Dwarf mistletoe class system (see text for citation).

The present condition of each recreation site is described below. General information on basal area (BA), quadratic stand diameter, and # of stems per acre is given in Table II and the DMR for each site is listed in Table III. Only Rock Crossing CG showed a significant amount of southwestern dwarf mistletoe (DM) (see Biology of Pests) infection in the overstory trees.

Pine Flat CG: Primarily a ponderosa pine site with a small Douglas-fir, oak, and juniper component. A few riparian species (Arizona walnut, maple, boxelder, and poison ivy) border the creek. This CG had been previously thinned and pruned (including DM brooms), approximately three to four years ago, to increase health of residual trees and protect against bark beetle outbreak. All recorded hazard trees are in high use (risk) areas. Three trees have a high probability of failure within the next five years; two are dead ponderosa pines, the third a Gambel oak with a dead top. The other hazard trees, in the medium failure rating, have weak forked tops and/or a significant degree of lean. The DMR of this site is low, with most infection occurring in the 11+ DBH category in the southwest corner of the campground. Dwarf mistletoe plants are prominent on the bole of some pruned trees but past research has shown that bole infections are not vigorous and do not have a significant impact on the health of a tree (Lightle and Hawksworth, 1973).

Cave Springs CG: Mostly composed of pole and immature sawtimber-sized ponderosa pine, with scattered large yellow pines. No insect or disease activity was recorded during this survey. However, mortality due to bark beetle infestation has occurred in the past and pine engraver beetle and western pine beetle activity was observed in close proximity last year. Because this site is densely stocked (BA = 164), thinning is recommended in order to decrease likelihood of bark beetle infestation. Under the current drought conditions we advise treating during July through December in order to reduce the risk of outbreaks (see Biology of Pests).

Red Rock PA: Due to the type of hardwoods (sycamore and cottonwood) on this site and the amount soil compaction from heavy use, there are many defective trees. The majority of recorded hazard trees have a high probability of failure within the next five years and judicious pruning of defective limbs is recommended. A vegetation management plan is desirable with emphasis on putting some areas to rest in order to establish regeneration. Aside from the hazard trees, no significant insect or disease problems were found at Red Rock

PA and a stand examination was not performed on this site.

Moqui Use CG: This site has a strong oak component mixed with ponderosa pine. There are three dead trees which pose a high risk over a recently constructed campsite. Dwarf mistletoe infection was not observed.

Rock Crossing CG: This is a very open site with a few large yellow ponderosa pines and pockets of densely stocked seedlings, saplings, or poles. There are also some fairly large junipers and clumps of oak. The majority of the overstory pines are severely infected with DM (stand DMR = 2) and are exposed to strong winds on this barren site. Although DM infection was not observed in the understory trees during this survey, latent infection is inherent due to their location under infected overstory trees. Treatment to suppress DM infection in this campground should be evaluated. Most of the infected overstory trees are above the suggested DMR limit which responds favorably to pruning (see Biology of Pests), yet regeneration needs to be protected. Since removal of these trees would decrease the appeal of the campground ethephon treatments may be desirable. This would inhibit spread of the disease to the understory and maintain cover until the overstory trees are replaced.

Pine Grove CG: The site is an open stand with a few large, yellow pines. No major insect and disease problems were recorded. Many of the pines have lightening strikes but decay was not observed in increment cores. Only one hazard tree, a small diameter snag, was observed at one of the campsites where it poses a threat to the tent pad.

BIOLOGY OF PESTS

Southwestern Dwarf Mistletoe - Arceuthobium vaginatum subsp. cryptopodum:

Southwestern dwarf mistletoe (SWDM) is the most damaging disease of southwestern ponderosa pine, Pinus ponderosa var. scopulorum Engelm, (Hawksworth, 1961). Dwarf mistletoes are parasitic, seed-bearing plants that depend on their hosts almost completely for their water and nutrients. The disease spreads by explosively released seeds which are expelled to distances ranging from 10 to 40 feet. Seeds of SWDM are released in late July and early August. Infection follows a few months after dispersal, most taking place through the bark on needle-bearing portions of twigs. Dwarf mistletoes first produce an endophytic system, a specialized root-like structure that is in contact with the phloem and xylem of host trees, from which the parasite obtains most of its nutrients and water. The aerial shoots appear between two to five years after infection; this period of infection before shoots are visible is known as the latent period.

The disease causes mortality and growth reduction in infected trees: A decrease in the quantity, quality, and germination percentage of seeds produced; and lowers timber quality. Severely infected trees are more susceptible to attacks by insects and other diseases and to environmental stresses such as drought. Heavily infected trees (DMR = 5 or 6) may sustain a 20 to 50 percent reduction in growth when compared to uninfected trees and their life expectancy is severely decreased (Lightle and Hawksworth, 1973). Dwarf mistletoe infects trees of all ages and is thus a problem in second growth and regeneration, as well as mature and overmature stands.

Spread of SWDM is a function of stand density, age, and site index, and averages one to two feet a year. Spread is most efficient and rapid from an infected overstory to an understory and slowest through an even-aged stand. Management of SWDM is directed toward decreasing spread and intensification of disease since DM eradication is achieved only by removing the entire stand of trees.

The following suggestions for DM control in recreational forests are offered based on a 20 year study by Lightle and Hawksworth (1973):

-Pruning is recommended in lightly infected trees (DMR <3). Remove branches two whorls above highest DM-infected branch to insure against latent infections. No more than 50% of the live crown should be removed.

-Confine pruning to more isolated trees. Repruning has been required in densely stocked stands due to numerous latent infection in areas initially considered lightly infected.

-Infected branches should be cut off at the bole in order to insure removal of the endophytic, root-like, system in the host tissue.

-Trees with bole infections do not need to be killed since bole infections are not vigorous.

-Pruning witches brooms on heavily infected trees (DMR = 3-4) does prolong life. A shorter life expectancy corresponds to higher DMR.

Other management strategies include:

-Sanitize densely stocked stands. The most severely infected trees are removed to eliminate much of the inoculum and promote vigor of lightly and noninfected trees.

-Remove severely infected overstory trees. A vegetation management plan is desirable, with emphasis on nonhost species eventually replacing DM-infected trees.

-Apply ethylene-releasing chemicals to promote abscission of dwarf mistletoe aerial shoots (Beatty, et.al., 1988; Nicholls, et.al., 1987). This method greatly reduces seed dispersal; the pathogen is not eliminated since the endophytic system remains viable within the host tissue and new aerial shoots form in two to five years. Chemicals need to be reapplied every few years, making this method suitable to high value areas only where susceptible trees have become established under an infected overstory.

Western Pine Beetle - Dendroctonus brevicomis:

Western pine beetles mass-attack stands of ponderosa pine, carrying and transmitting fungi which aid in killing the host. Western pine beetles produce between two and four generations per year depending on latitude and elevation. Flight and attacks start in late spring or early summer and continue until the onset of cold weather (DeMars, 1982). Western pine beetle attacks are

initiated by adult females, usually at mid bole. Evidence of attack is marked by white to reddish pitch tubes on the bark. The attack process is mediated by chemical messengers or pheromones released by the beetles in combination with host terpenes. The beetles excavate winding sinuous egg galleries under the bark which often cross. Eggs are laid in niches chewed into the sides of the gallery. Once the eggs hatch the larvae feed in short galleries perpendicular to the parent gallery. Later larval stages feed in the middle bark. Pupation also occurs there. Brood adults first feed in the middle and outer bark before emerging. This cycle varies in length from two to ten months depending on temperature.

This insect usually breeds in scattered, slow growing overmature trees and diseased or damaged trees. Group-killing is also common in dense, overstocked stands of young sawtimber. Trees under six inches in diameter are seldom attacked. Environmental stresses which permanently weaken individual or small groups of trees (root diseases, mistletoes, mechanical damage) or temporarily weaken whole stands (droughts, defoliators, fires) predispose trees to attack and create conditions for outbreaks to occur. A good example was documented in southern California where effects of ozone damage were examined. There it was found that beetle productivity was greater in ozone damaged trees since fewer attacks were required to kill the tree. The ratio of brood emergence to attacking beetles was greater for the ozone affected trees.

There are a number of natural enemies of this insect including woodpeckers, and several parasitic and predatory insects. However, the main factor thought to influence occurrence of outbreaks is the abundance of suitable hosts. Suppression of western pine beetle populations has often been found to be expensive and unsatisfactory since timely spotting and treatment is difficult. However, sanitation-salvage logging can be applied to minimize losses. Prevention of outbreaks is the most effective way of reducing losses. Unacceptable losses can be prevented in most circumstances (barring severe drought) by maintaining thrifty, vigorous trees. Thinning dense 70-80 year old sawtimber stands, thereby reducing stocking to 55-70 percent of the basal area necessary for full site utilization, relieves competitive stress among remaining trees, making them less prone to successful attack.

Individual high value trees that are predisposed to attack by temporary injury may be given a protective residual bark spray to prevent successful attack. Such treatment can be effective if the protection for one or two years would allow the tree to recover. It should not be considered for trees suffering from severe root disease or damage.

Pine Engraver Beetles - Ips spp.

Several species of pine engraver beetles attack downed and standing ponderosa pine in the Southwest, including Arizona five-spined engraver, I. lecontei; the pine engraver, I. pini; the six-spined engraver, I. calligraphus; I. knausi, and I. integer. The beetles usually produce two to four generations per year depending on climate and elevation (Parker, 1979; Sartwell, et. al. 1971). Flight and attacks usually begin in April or May, whenever daily maximum temperatures reach 60-70 degrees F. (Livingston, 1979) and continue until the onset of cold weather. Engraver beetle attacks are initiated by adult males. Evidence of attack is marked by reddish-brown boring dust in bark crevices and at the tree base on standing trees. Occasionally small pitch tubes are

formed. The attack process is mediated by pheromones released by the beetles in combination with host terpenes. The male is joined by one to many females. After mating, each female constructs an egg gallery in the inner bark, slightly scoring the wood surface in the process. Very often the galleries will form an inverted Y pattern oriented parallel to the grain of the wood (Sartwell et. al., 1971). Egg galleries are usually free of boring dust. This feature readily distinguishes them from the Dendroctonus spp. Eggs are laid on each side of the gallery. Larvae feed in mines that run laterally from the egg gallery. These larval mines are packed with frass. Pupation occurs in an oval cell chewed by the larva. Brood adults may congregate and feed under bark before emerging (Sartwell et. al., 1971). In the Southwest, this cycle varies in length from about one month in mid summer to eighty days at other times (Parker, 1979).

These insects prefer to attack freshly cut slash, windthrow and snow broken material, particularly the spring attacking generation (Livingston, 1979). Standing green trees may also be attacked, but many times only the tops are killed on larger trees. Outbreaks in unthinned young stands may result in the death of groups of 50 to more than 500 trees (Sartwell et. al., 1971). Parker (1979) describes results of an outbreak in central Arizona. The average loss in that outbreak was 176 trees per acre, or 91 percent of all trees three inches in diameter and greater. The total gross acres affected was 7,000. A number of factors may increase pine engraver activity:

-presence of green slash in spring (January-June) (Livingston, 1979, Parker, 1979),

-spring drought (<75 percent normal precipitation) (Livingston, 1979),

-stagnating stand conditions (Livingston, 1979),

-diseases such as DM (Parker, 1979).

The most damaging outbreaks occur when fresh slash or weakened trees are present in the same area for two or more consecutive years (Parker, 1979).

A number of natural factors help hold populations in check, however, preventative measures are most effective in reducing losses. A number of preventative tactics are described in the Cutting Methods Handbook (2409.26a, Chapter 62):

-Maintain or improve stand vigor through precommercial and commercial thinning,

-monitor green slash and standing trees for evidence of infestation, particularly during April-July in drought years,

-where the threat of Ips is a concern, slash creating activities should be conducted from July-December,

-minimize creation of slash during the months of January-June (When it is impractical to do this, slash should be chipped, burned, or crushed. In some cases a lop and scatter treatment to promote drying is sufficient),

-avoid management activities that create slash or weakened trees for two or more consecutive years in the same area.

Determining whether or not to attempt to suppress an existing Ips population in slash is difficult. Suppression may not be successful if infestations are not detected early enough. Further, there is no reliable method to determine if populations in slash will attack nearby standing trees. For more information on recommended suppression methods please refer to the Cutting Methods Handbook (2409.26a, Chapter 62).

MANAGEMENT ALTERNATIVES

1. Do nothing. Trees rated as potential hazards will continue to decline and the probability of failure will increase. Trees will continue to be damaged by campers and by natural causes, so the number of potential hazards will also increase. The possibility of tree failure with property damage and injury to people will increase. Dwarf mistletoe-infected trees will continue to decline in health and vigor and serve as inoculum for spread and intensification of disease. Risk of mortality will exist on densely stocked sites, especially those which are severely infected with DM, due to susceptibility to attack by bark beetles.

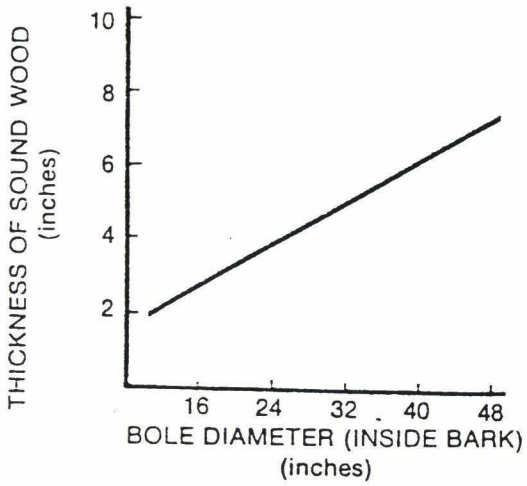

Figure I. Thickness of sound wood in outer shell required to maintain 66% of original strength in trees with heart rot (from Johnson, 1981). If the amount of sound wood exceeds that established by the line on the graph, the tree is considered relatively safe from failure.

2. Remove or lessen the probability of failure of hazard trees. The land manager must decide the level of risk acceptable in an area and hazard trees would be removed or treated until that risk level is reached. In many cases, pruning dead branches and large brooms would substantially reduce the probability of failure. Dead tops on conifers should be removed as soon as practical (Mills and Russell, 1981). For trees showing signs of internal decay, the thickness of sound wood in the outer shell determines relative safety (Figure 1). Trees that lean naturally usually are reinforced by compensatory growth. However, structural damage to leaning trees, such as severed roots and large basal cavities, increase the probability of failure and threatens visitor safety.

3. Remove the targets. Under this alternative, campgrounds or selected areas within campgrounds that are identified as targets are closed to public use. Removal of potential targets will remove the problem of hazard trees.

4. Develop a vegetation management plan which reduces incidence of insect and disease and development of hazard trees. This may include activities such as: Thinning a dense stand of trees which reduces stress and probability of bark beetle attack; sanitizing to decrease the incidence of DM infection; pruning DM-infected trees to prolong life; and planting nonhost species under a DM-infected ponderosa pine overstory.

5. A combination of alternatives 2 and 3 and 4. These alternatives are not mutually exclusive and can be used in combination to solve specific problems in many areas.

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APPENDIX A

TREE HAZARD EVALUATION

EXHIBIT 8

Administrative unit SEDONA

Examined by TS, TR, MLF

Site name Pine Flat

Date 6-19-89

Campground or Picnic Unit No.	Tree location (azimuth and distance from fixed object)[1]	Species	DIB	*See abbreviations Type of defect: Leaning (angle of lean °)	Uprooting, root rot, butt rot, basal cavity	Bole wounds, bole cankers, decay (conks)	Weak fork, limb defect, brooms, dead top	Potential targets: Permanent structure, parked vehicle, people	Temporary structure, high-use trails	Low-use trails, signs	Failure rating[2]: High	Medium	Low	Risk rating[3]: High	Medium	Low	Additional comments	Actio
	Abbreviations: TO=Toilet, TB=Table, FR=Fire ring, PP=Parking pad, TP=Tent Pad, WH=Water hydrant, BG=Bridge, TC=Trash can, TD=Trailer dump																*Defect abbreviations: RR=Root rot, BR=Bole or butt rot, BW=Bole wound, BC=Basal cavity, LD=Limb defect, WF=Weak fork, C=Conk(s), DT=Dead top, ER=Exposed roots	13
14	FR 50° 95ft	PP	29	15°			WF	X				X		X				
	FR 63° 49ft.	PP	28				WF	X				X		X				
25	FR 136° 10ft	PP	7.5	7°				X			X			X			Dead tree	
36	FR 62° 51ft.	PP	13.2				DT	X			X			X			Whole tree is fading	
49	FR 288° 24.5ft	GO	9.6				DT	X			X			X			Broken top leaning against branches of ponderosa, ready to fall.	
56	FR 104° 21.5ft	PP	8.7				WF		X			X		X				

1 Sketch map on reverse side.
2 Probability of a tree failing within the next 5 years.
3 Probability of a tree hitting a potential target.

PP = Ponderosa Pine
GO = Gambell Oak

TREE HAZARD EVALUATION

EXHIBIT 8

Administrative unit Sedona

Examined by TS TR MLF

Site name Pine Flat

Date 6-19-89

3 of

Campground or Picnic Unit No.	Tree location (azimuth and distance from fixed object)[1] Abbreviations: TO=Toilet TB=Table FR=Fire ring PP=Parking pad TP=Tent Pad WH=Water hydrant BG=Bridge TC=Trash can TD=Trailer dump	Species	D.b.h.	*See abbreviations Type of defect: Leaning (angle of lean °)	Uprooting, root rot, butt rot, basal cavity	Bole wounds, bole cankers, decay (conks)	Weak fork, limb defect, brooms, dead top	Potential targets: Permanent structure, parked vehicle, people	Temporary structure, high-use trails	Low-use trails, signs	Failure rating[2]: High	Medium	Low	Risk rating[3]: High	Medium	Low	Additional comments	Actio
																	*Defect abbreviations: RR=Root rot BR=Bole or butt rot BW=Bole wound BC=Basal cavity LD=Limb defect WF=Weak fork C=Conk(s) DT=Dead top ER=Exposed roots	14
14	FR 50° 95ft	PP	29	15°				X				X		X			Forked top - major lean is in top ½ of tree	possible C
	FR 63° 49ft	PP	28					X				X		X			Broken fork - [illegible] decay C	
25	FR 136° 102ft	PP	7½	7°	RR-ER			X			X			X			Dead Tree	
[illegible]	FR 275° 50ft	Az Alder	19	—	BC			X		X			X	X			Located on flat ground, [illegible] along creek, upright tree	
33	FR 275° 18½'	PP	27	14°	BR			X					X	X			Tree has fungus in base [illegible] to [illegible], big [illegible] danger [illegible] be to camp sites #32 & #34	

1 Sketch map on reverse side.

2 Probability of a tree failing within the next 5 years.

3 Probability of a tree hitting a potential target.

TREE HAZARD EVALUATION

EXHIBIT 8

Administrative unit Sedona ~~MORMON LAKE R.D.~~ Examined by TS TR MF

Site name Pine FD. ST Date 7/5/89

Campground or Picnic Unit No.	Tree location (azimuth and distance from fixed object)[1]	Species	D.b.h.	*See abbreviations Type of defect: Leaning (angle of lean °)	Uprooting, root rot, butt rot, basal cavity	Bole wounds, bole cankers, decay (conks)	Weak fork, limb defect, brooms, dead top	Potential targets: Permanent structure, parked vehicle, people	Temporary structure, high-use trails	Low-use trails, signs	Failure rating[2]: High	Medium	Low	Risk rating[3]: High	Medium	Low	Additional comments	Acti
	Abbreviations: TO=Toilet, TB=Table, FR=Fire ring, PP=Parking pad, TP=Tent Pad, WH=Water hydrant, BG=Bridge, TC=Trash can, TD=Trailer dump																*Defect abbreviations: RR=Root rot, BR=Bole or butt rot, BW=Bole wound, BC=Basal cavity, LD=Limb defect, WF=Weak fork, C=Conk(s), DT=Dead top, ER=Exposed roots	
49	FR 20° 24½'	GO	9.6				DT				X			X			Broken top leaning ...	
56	FR 104° 21½'	PP	8.7				WF		X			X			X			
57	FR 240° 13'	PP	11				WF		X			X			X			
~~44~~	~~FR 70° 19'~~	~~GO~~	~~8~~				~~DT~~	X					X	X			~~Alive~~	
~~45~~	~~FR 46° 2'~~	~~GO~~	~~11.5~~		~~UC~~	~~L~~	~~DT~~	X				X		X			~~Alive~~	
~~41~~	~~FR 278° 74'~~	~~H~~	~~1~~		~~L~~	~~L~~			~~X~~			~~X~~				X		
~~46~~	~~FR 55° 51'~~	~~PP~~	~~11.7~~				~~DT~~	X				~~X~~	X	X				
~~42~~	~~FR 62° 51'~~	~~PP~~	~~12.2~~				~~DT~~	X				X		X			~~Dead tree~~	
~~50~~	~~FR 199° 5.1'~~	~~PP~~	~~15.2~~		~~UC~~			X					X	X				

1 Sketch map on reverse side.

2 Probability of a tree failing within the next 5 years.

3 Probability of a tree hitting a potential target.

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TREE HAZARD EVALUATION

EXHIBIT 8

Administrative unit Sedona RD

Examined by TODD's

Site name Cave Springs

Date 7-25-89

Campground or Picnic Unit No.	Tree location (azimuth and distance from fixed object)[1] Abbreviations: TO=Toilet TB=Table FR=Fire ring PP=Parking pad TP=Tent Pad WH=Water hydrant BG=Bridge TC=Trash can TD=Trailer dump	Species	D.B.H.	*See abbreviations Type of defect: Leaning (angle of lean °)	Uprooting, root rot, butt rot, basal cavity	Bole wounds, bole cankers, decay (conks)	Weak fork, limb defect, brooms, dead top	Potential targets: Permanent structure, parked vehicle, people	Temporary structure, high-use trails	Low-use trails, signs	Failure rating[2]: High	Medium	Low	Risk rating[3]: High	Medium	Low	Additional comments	Actio
																	*Defect abbreviations: RR=Root rot BR=Bole or butt rot BW=Bole wound BC=Basal cavity LD=Limb defect WF=Weak fork C=Conk(s) DT=Dead top ER=Exposed roots	16
A18	TB: 121°, 79'	PP	34			BW		X					X	X			Large Bole Wound w/decay	
A12	TB: 60°, 72'	AW	11					X			X			X			Dead Tree	
A13	TB: 267°, 56'	PP	41		X		X	X			X			X				
E4	TB: 104°, 12'	PP	33				LD	X			X			X			- Dead limb	
E13	TB: 44°, 7'	PP	29	7°								X		X				

1 Sketch map on reverse side.

2 Probability of a tree failing within the next 5 years.

3 Probability of a tree hitting a potential target.

PP = Ponderosa pine

AW = Arizona white oak

TREE HAZARD EVALUATION

EXHIBIT 8

Administrative unit Sadlon R.D. Examined by TODD

Site name CAVE SPRINGS C.G. Date 7-25-89

Campground or Picnic Unit No.	Tree location (azimuth and distance from fixed object)[1]	Species	D.b.h.	*See abbreviations Type of defect: Leaning (angle of lean °)	Uprooting, root rot, butt rot, basal cavity	Bole wounds, bole cankers, decay (conks)	Weak fork, limb defect, brooms, dead top	Potential targets: Permanent structure, parked vehicle, people	Temporary structure, high-use trails	Low-use trails, signs	Failure rating[2]: High	Medium	Low	Risk rating[3]: High	Medium	Low	Additional comments	Actions
	Abbreviations: TO=Toilet, TB=Table, FR=Fire ring, PP=Parking pad, TP=Tent Pad, WH=Water hydrant, BG=Bridge, TC=Trash can, TD=Trailer dump																*Defect abbreviations: RR=Root rot, BR=Bole or butt rot, BW=Bole wound, BC=Basal cavity, LD=Limb defect, WF=Weak fork, C=Conk(s), DT=Dead top, ER=Exposed roots	
	121°, 79' → TB A18	PP	34			X		X					X	X			LARGE Bole Wound W/ ROT	
	60°, 72' → TB A12	AW	11					X			X			X			DEAD TREE	
	267°, 56' → TB A13	PP	41		X		X	X			X			X				
?	104°, 12' → TB E4	PP	33				X	X			X			X			LD - DEAD	
	414°, 7' → TB E13	PP	29	7°								X		X			WEAK TOP	
	253°, 60' → TB C7	PP	21	15°								X				X		

1 Sketch map on reverse side.
2 Probability of a tree failing within the next 5 years.
3 Probability of a tree hitting a potential target.

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TREE HAZARD EVALUATION

EXHIBIT 8 1 of 4

Administrative unit SEDONA RD

Examined by Borys Mindy S, J. Beard MF

Site name Redrock

Date 9-5-89

	Campground or Picnic Unit No.	Tree location (azimuth and distance from fixed object)[1] Abbreviations: TO=Toilet TB=Table FR=Fire ring PP=Parking pad TP=Tent Pad WH=Water hydrant BG=Bridge TC=Trash can TD=Trailer dump	Species	DIB	*See abbreviations Type of defect: Leaning (angle of lean °)	Uprooting, root rot, butt rot, basal cavity	Bole wounds, bole cankers, decay (conks)	Weak fork, limb defect, brooms, dead top	Potential targets: Permanent structure, parked vehicle, people	Temporary structure, high-use trails	Low-use trails, signs	Failure rating[2]: High	Medium	Low	Risk rating[3]: High	Medium	Low	Additional comments	Acti
																		*Defect abbreviations: RR=Root rot BR=Bole or butt rot BW=Bole wound BC=Basal cavity LD=Limb defect WF=Weak fork C=Conk(s) DT=Dead top ER=Exposed roots	18
1	1	TB 1425° 215ft	SY	160				LD		X		X				X		Limb towards table girdled by woodborers	
2		TB 240° 32ft	C	21	X	Dead tree				X		X				X		Leaning on trail	
3		TB 291° 375ft	SY	63		Huge Basal Cavity	Internal Decay	LD	X			X			X			DIB actually at Root collar	
4	2	TB 80° 21ft	SY	14		BC							X		X			Evaluate in 10 yrs	
5		TB 162° 27ft	C	20				LD				X					X	No decay, Prune branches	
6		TB 309° 18ft	SY	146				LD					X		X			Prune out branches w/ Internal decay. Also	
7		TB 80° 50ft	SY	197				BC						X	X			clean up widow makers	
																		BC → No decay detected	

1 Sketch map on reverse side.

2 Probability of a tree failing within the next 5 years.

3 Probability of a tree hitting a potential target.

Sy → sycamore

C → cottonwood

CY → cypress

TREE HAZARD EVALUATION

EXHIBIT 8

Administrative unit Sedona RD

Examined by _____ pg 2 of 4

Site name Redrock crossing

Date 9-5-89

Campground or Picnic Unit No.	Tree location (azimuth and distance from fixed object)[1] Abbreviations: TO=Toilet TB=Table FR=Fire ring PP=Parking pad TP=Tent Pad WH=Water hydrant BG=Bridge TC=Trash can TD=Trailer dump	Species	D.B.H.	*See abbreviations Type of defect: Leaning (angle of lean °)	Uprooting, root rot, butt rot, basal cavity	Bole wounds, bole cankers, decay (conks)	Weak fork, limb defect, brooms, dead top	Potential targets: Permanent structure, parked vehicle, people	Temporary structure, high-use trails	Low-use trails, signs	Failure rating[2]: High	Medium	Low	Risk rating[3]: High	Medium	Low	Additional comments	Actio
8 3	TB 150° 27ft	C	31				LD			X		X		X			Prune limbs	
9	309° 7.3	SY	15.5		BC	Decay						X		X			decay - check in 5yrs	
10	310° 9.0	SY	10.0		Dead tree			X	X		X			X			Dead tree	
11	289° 27.0	SY	30.1		BC								X		X		Buttressing over old stump, no decay	
12 4	TB 282° 7ft.	CY	7.0				DT	X				X		X			judicious pruning probably OK	
13 5	TB 359° 23.5	SY	21.4					X			X			X			Prune	
14	341° 30.0	SY	16.9		BC		DT			X	X				X		Sound/ prune dead top	
15	336° 30.0	SY	15.5				DT			X	X				X		prune - dead top	

1 Sketch map on reverse side.

2 Probability of a tree failing within the next 5 years.

3 Probability of a tree hitting a potential target.

*Defect abbreviations:
RR=Root rot
BR=Bole or butt rot
BW=Bole wound
BC=Basal cavity
LD=Limb defect
WF=Weak fork
C=Conk(s)
DT=Dead top
ER=Exposed roots

TREE HAZARD EVALUATION

EXHIBIT 8

Administrative unit Sedona RD

Examined by 3 of 4

Site name Redrock crossing PA

Date 9-5-89

Campground or Picnic Unit No.	Tree location (azimuth and distance from fixed object)[1] Abbreviations: TO=Toilet TB=Table FR=Fire ring PP=Parking pad TP=Tent Pad WH=Water hydrant BG=Bridge TC=Trash can TD=Trailer dump	Species	D.b.h.	*See abbreviations Type of defect: Leaning (angle of lean °)	Uprooting, root rot, butt rot, basal cavity	Bole wounds, bole cankers, decay (conks)	Weak fork, limb defect, brooms, dead top	Potential targets: Permanent structure, parked vehicle, people	Temporary structure, high-use trails	Low-use trails, signs	Failure rating[2]: High	Medium	Low	Risk rating[3]: High	Medium	Low	Additional comments *Defect abbreviations: RR=Root rot BR=Bole or butt rot BW=Bole wound BC=Basal cavity LD=Limb defect WF=Weak fork C=Conk(s) DT=Dead top ER=Exposed roots	Actio
16 5	TB 228° 43ft	C	42.4				LD						X			X	Prune! out dead limbs	
17 8	TB 236° 16	SY	22.6		Dead tree						X			X			actually more hazardous to #7 (little of center has decay)	
18	234° 10.5	SY	28				LD/DT				X			X			widow maker top needs to be removed Prune	
19	150° 19.5	SY	30.3		Dead top						X			X			widow maker "/ Prune it	
20 9	TB 160° 60	SY	16.7		Dead top		LD				X				X		PRUNE!	

1 Sketch map on reverse side.
2 Probability of a tree failing within the next 5 years.
3 Probability of a tree hitting a potential target.

TREE HAZARD EVALUATION

EXHIBIT 8

Administrative unit Sedona RD

Examined by 4 of 4

Site name Redrock crossing

Date 9-5-89

Campground or Picnic Unit No.	Tree location (azimuth and distance from fixed object)[1]	Species	D.b.h.	*See abbreviations Type of defect: Leaning (angle of lean °)	Uprooting, root rot, butt rot, basal cavity	Bole wounds, bole cankers, decay (conks)	Weak fork, limb defect, brooms, dead top	Potential targets: Permanent structure, parked vehicle, people	Temporary structure, high-use trails	Low-use trails, signs	Failure rating[2]: High	Medium	Low	Risk rating[3]: High	Medium	Low	Additional comments	Actic
Abbreviations: TO=Toilet, TB=Table, FR=Fire ring, PP=Parking pad, TP=Tent Pad, WH=Water hydrant, BG=Bridge, TC=Trash can, TD=Trailer dump																	*Defect abbreviations: RR=Root rot, BR=Bole or butt rot, BW=Bole wound, BC=Basal cavity, LD=Limb defect, WF=Weak fork, C=Conk(s), DT=Dead top, ER=Exposed roots	21
10	TB 316 14.5ft	SY	36				LD				X			X			Judicious pruning in the Winter	
	244 12.5ft	SY	15.8		Remove	Dead	Top & Prune it!				X			X			" "	
	121 33ft	SY	20.1				LD				X				X		" "	
all	128 40ft	SY	19				LD				X				X		" "	
together	128° 40ft	SY	17				LD				X				X		" "	
	128° 40ft	SY	14.8				LD				X				X		" "	

1 Sketch map on reverse side.
2 Probability of a tree failing within the next 5 years.
3 Probability of a tree hitting a potential target.

TREE HAZARD EVALUATION

EXHIBIT 8

Administrative unit Blueridge

Examined by Todd's

Site name Moqui Use CG

Date 8/22/89

Campground or Picnic Unit No.	Tree location (azimuth and distance from fixed object)[1] Abbreviations: TO=Toilet TB=Table FR=Fire ring PP=Parking pad TP=Tent Pad WH=Water hydrant BG=Bridge TC=Trash can TD=Trailer dump	Species	D.b.h.	*See abbreviations Type of defect: Leaning (angle of lean °)	Uprooting, root rot, butt rot, basal cavity	Bole wounds, bole cankers, decay (conks)	Weak fork, limb defect, brooms, dead top	Potential targets: Permanent structure, parked vehicle, people	Temporary structure, high-use trails	Low-use trails, signs	Failure rating[2]: High	Medium	Low	Risk rating[3]: High	Medium	Low	Additional comments	Actio
																	*Defect abbreviations: RR=Root rot BR=Bole or butt rot BW=Bole wound BC=Basal cavity LD=Limb defect WF=Weak fork C=Conk(s) DT=Dead top ER=Exposed roots	22
Pad #1											X			X			3 Dead trees	
between pts. 5 & 6											X			X				
											X			X				

1 Sketch map on reverse side.

2 Probability of a tree failing within the next 5 years.

3 Probability of a tree hitting a potential target.

TREE HAZARD EVALUATION

EXHIBIT 8

Administrative unit Blue Ridge Ranger District

Examined by Todd Snider & Ralls

Site name Rock Crossing

Date 8-23-89

Campground or Picnic Unit No.	Tree location (azimuth and distance from fixed object)[1]	Species	DIB	*See abbreviations Type of defect: Leaning (angle of lean °)	Uprooting, root rot, butt rot, basal cavity	Bole wounds, bole cankers, decay (conks)	Weak fork, limb defect, brooms, dead top	Potential targets: Permanent structure, parked vehicle, people	Temporary structure, high-use trails	Low-use trails, signs	Failure rating[2]: High	Medium	Low	Risk rating[3]: High	Medium	Low	Additional comments	Actio
	Abbreviations: TO=Toilet, TB=Table, FR=Fire ring, PP=Parking pad, TP=Tent Pad, WH=Water hydrant, BG=Bridge, TC=Trash can, TD=Trailer dump																*Defect abbreviations: RR=Root rot, BR=Bole or butt rot, BW=Bole wound, BC=Basal cavity, LD=Limb defect, WF=Weak fork, C=Conk(s), DT=Dead top, ER=Exposed roots	23
2	FR, 19', 150°	GO	6				DT	X			X			X			Dead top	
2	FR, 19', 150°	GO	7.3				DT	X			X			X			Dead top	

1 Sketch map on reverse side.

2 Probability of a tree failing within the next 5 years.

3 Probability of a tree hitting a potential target.

GO = Gambel Oak

TREE HAZARD EVALUATION

EXHIBIT 8

Administrative unit Mormon Lake RD

Examined by JW, MLF

Site name Pine Grove CG

Date 7-6-89

Campground or Picnic Unit No.	Tree location (azimuth and distance from fixed object)[1] Abbreviations: TO=Toilet, TB=Table, FR=Fire ring, PP=Parking pad, TP=Tent Pad, WH=Water hydrant, BG=Bridge, TC=Trash can, TD=Trailer dump	Species	DIB	*See abbreviations Type of defect: Leaning (angle of lean °)	Uprooting, root rot, butt rot, basal cavity	Bole wounds, bole cankers, decay (conks)	Weak fork, limb defect, brooms, dead top	Potential targets: Permanent structure, parked vehicle, people	Temporary structure, high-use trails	Low-use trails, signs	Failure rating[2]: High	Medium	Low	Risk rating[3]: High	Medium	Low	Additional comments	Actio
																	*Defect abbreviations: RR=Root rot, BR=Bole or butt rot, BW=Bole wound, BC=Basal cavity, LD=Limb defect, WF=Weak fork, C=Conk(s), DT=Dead top, ER=Exposed roots	24
30	TB 138° 25.0'	PP	7.3					X			X			X			Snag 25' high butt rot	
39	FR 109° 100'	PP	32				X	X				X		X			Dead top	

1 Sketch map on reverse side.

2 Probability of a tree failing within the next 5 years.

3 Probability of a tree hitting a potential target.

PP = Ponderosa pine